

New Jersey Science Olympiad
March 2008 State Tournament

Oceanography C: Physical and geological oceanography.

Ground rules: You have 50 minutes to answer the questions in this test. You may bring a single 8.5" x 11" sheet of paper of computer-generated or handwritten notes per team. Notes may be written on both sides and may include graphics, tables, and/or text. Participants may bring any kind of calculator. No other resources, including computers, are permitted.

Each question is assigned a number of points between 4 and 8. In the event that two teams achieve identical scores, I will judge the quality of each team's responses to the more open-ended questions to determine how to break the tie, and I will explain why the performance of one team was judged to be superior to the other.

I hope you enjoy this event and continue the study of our Ocean Planet in college and beyond.

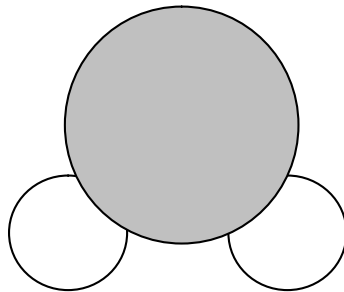
Question 1. (4 points.) Match each of the four major milestones in oceanography listed below with one of the following seven people or projects.

Possible choices:

- a) Charles Darwin
- b) James Cook
- c) Benjamin Franklin
- d) Topex Poseidon
- e) Matthew Maury
- f) ARGO floats
- g) Challenger Expedition

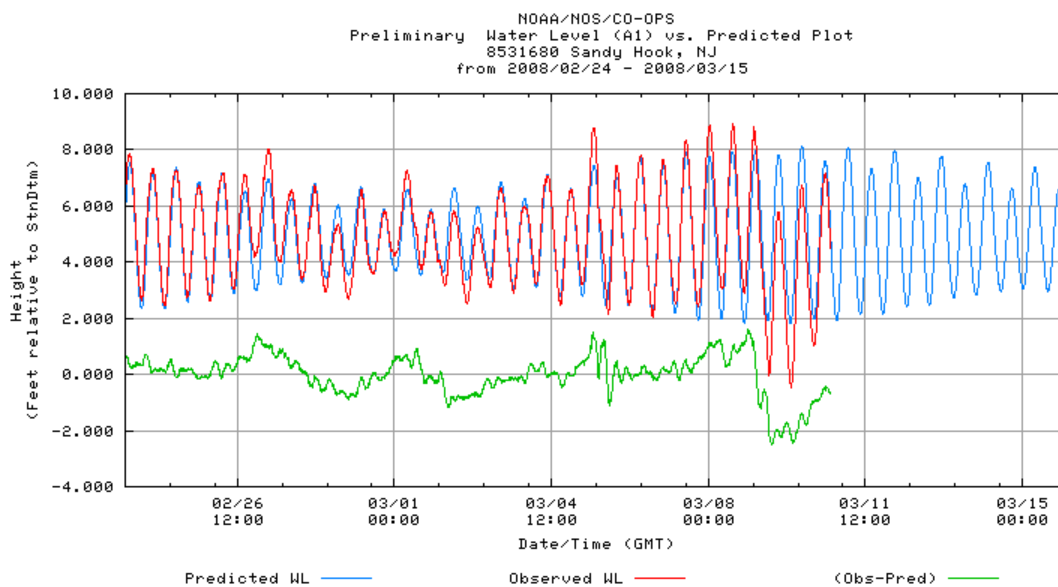
- 1. First chart of the Gulf Stream.
- 2. Measures sea surface height from space.
- 3. Proved that life exists on the deep seafloor.
- 4. First chart of the Great Barrier Reef.

Question 2. (5 points) The diagram below shows a water molecule. Label the atoms and show the approximate charge distribution. Describe three features of water that are a direct result of the shape and charge distribution of the water molecule.

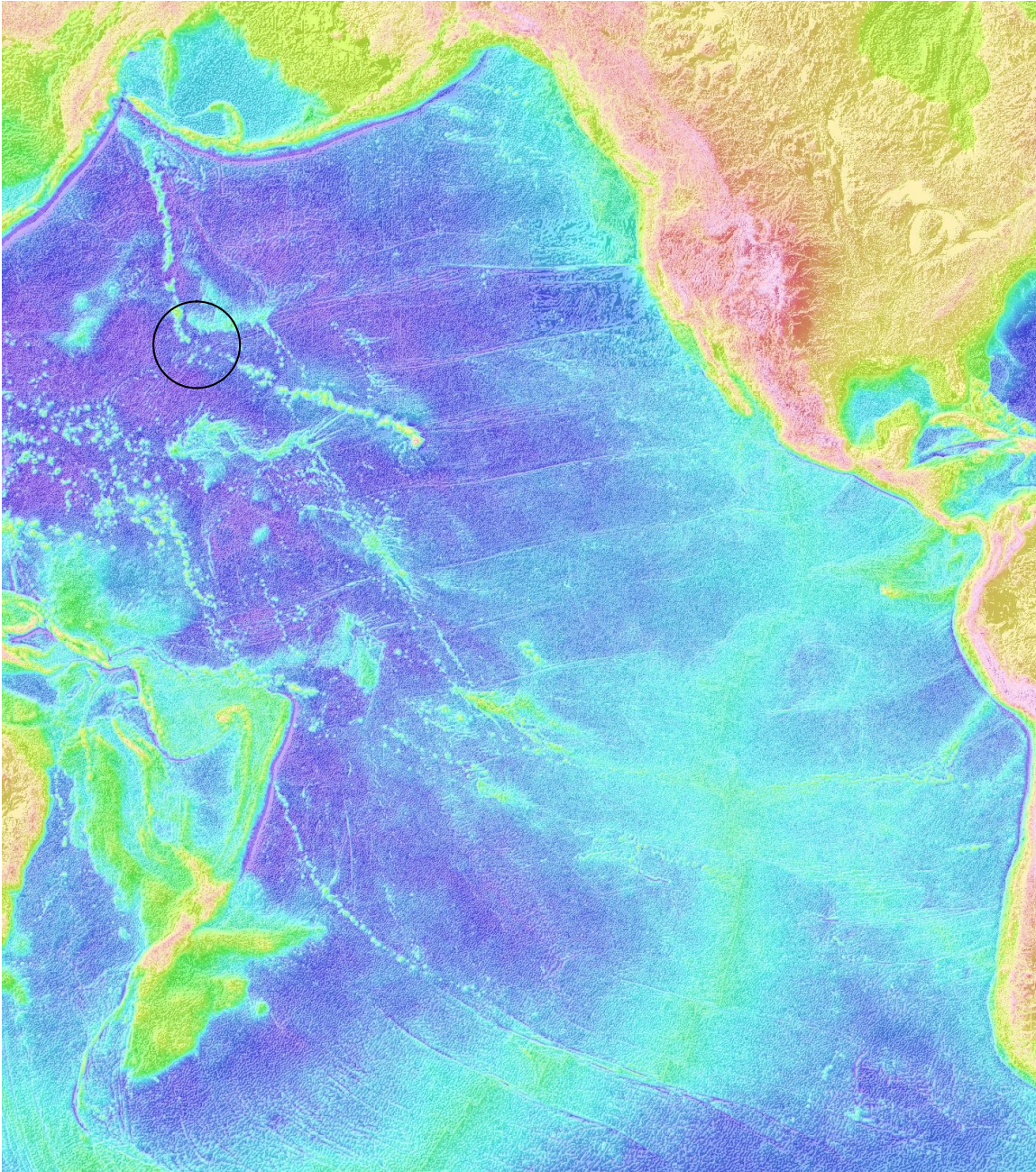


Question 3 (5 points) What is the approximate pH of seawater? Which ions control the pH of seawater? (Bonus point if you write this out in the form of a chemical equation.) What is happening today that is changing the pH of seawater? Describe one possible effect of this change.

Question 4 (5 points) The diagram below shows recent tide gauge measurements from Sandy Hook, New Jersey. On the diagram, draw arrows pointing to: a) a spring tide; b) a neap tide and c) a flood tide. Why are spring tides and neap tides different?



Question 5. (6 points) The image below shows the bathymetry of the Pacific Ocean with lighter blue showing shallower regions and deeper blue-purple showing deeper regions. Draw arrows showing a convergent plate boundary, a divergent plate boundary, a magma hot spot and a fracture zone.

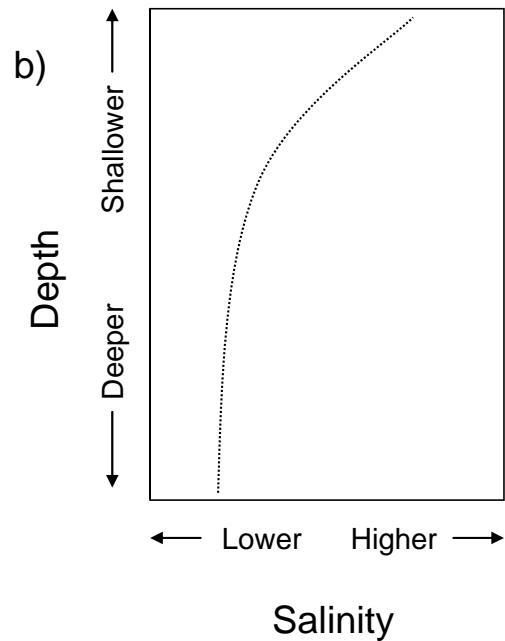
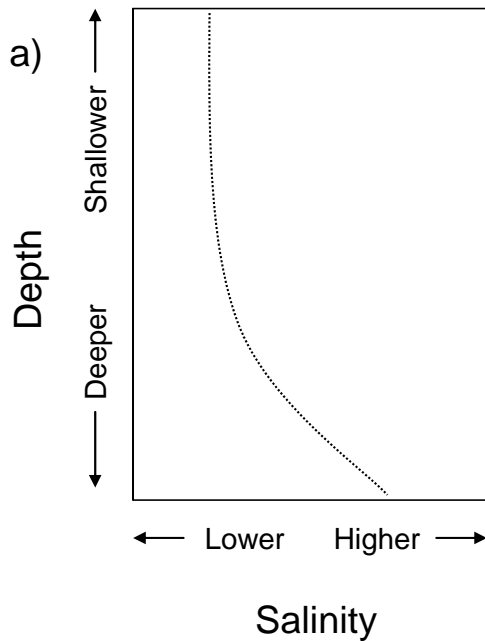


Bonus: The black circle shows the location of a kink in the Hawaiian-Emperor seamount chain. What event caused this kink and approximately when did it happen?

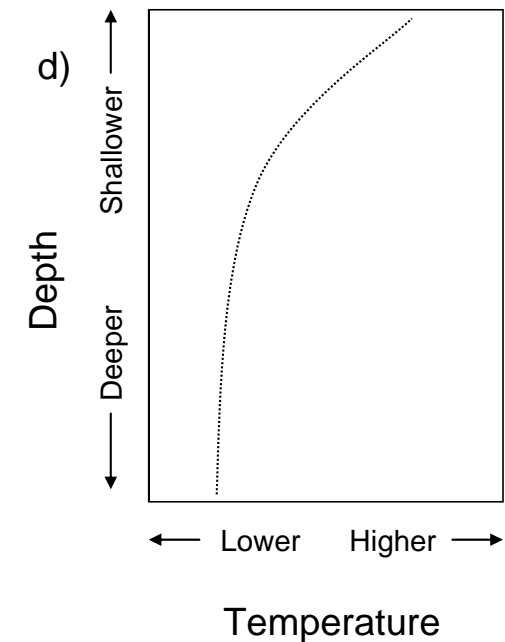
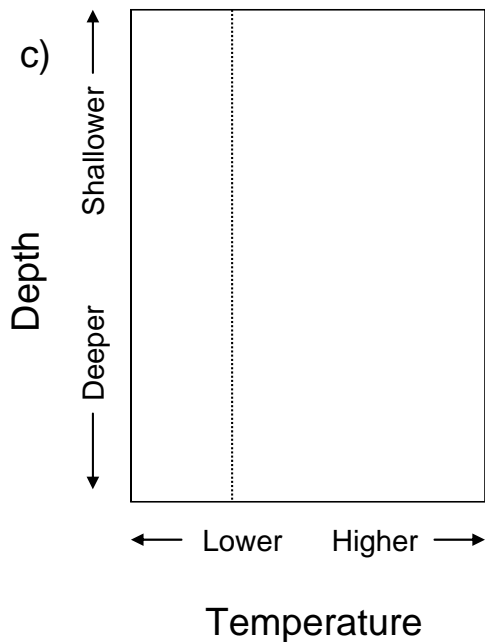
Question 6. (5 points) How do atolls form? Use drawings to illustrate the development of an atoll and describe which processes occur during its formation.

Question 7. (5 points.) In this question you will be looking at vertical profiles of temperature and salinity and considering the relative stability of each water column.

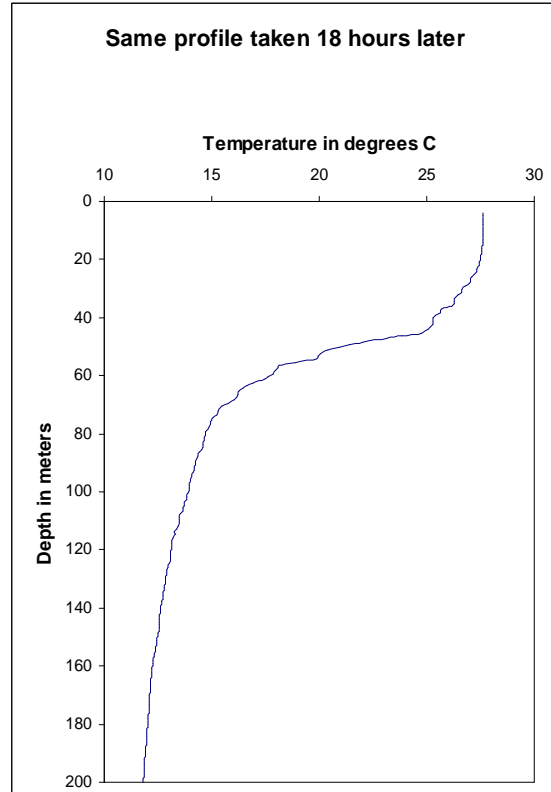
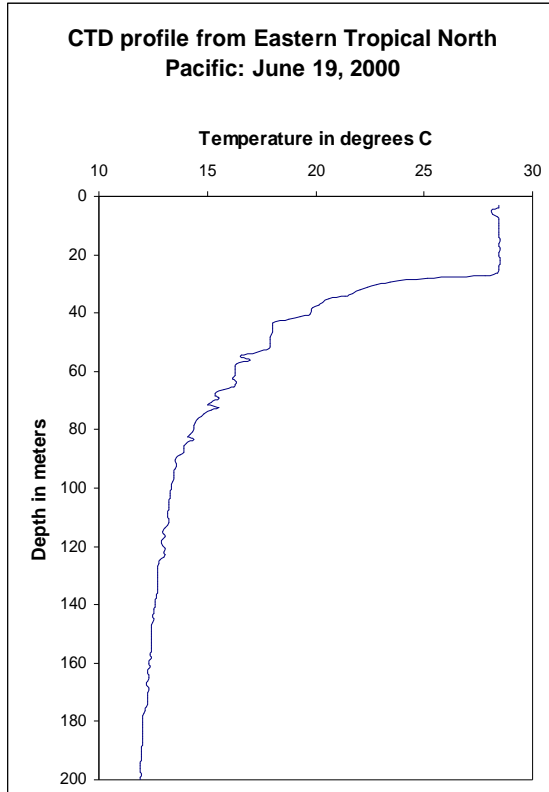
Profiles a) and b) show water columns with constant temperature and variable salinity. Which profile is more stable?



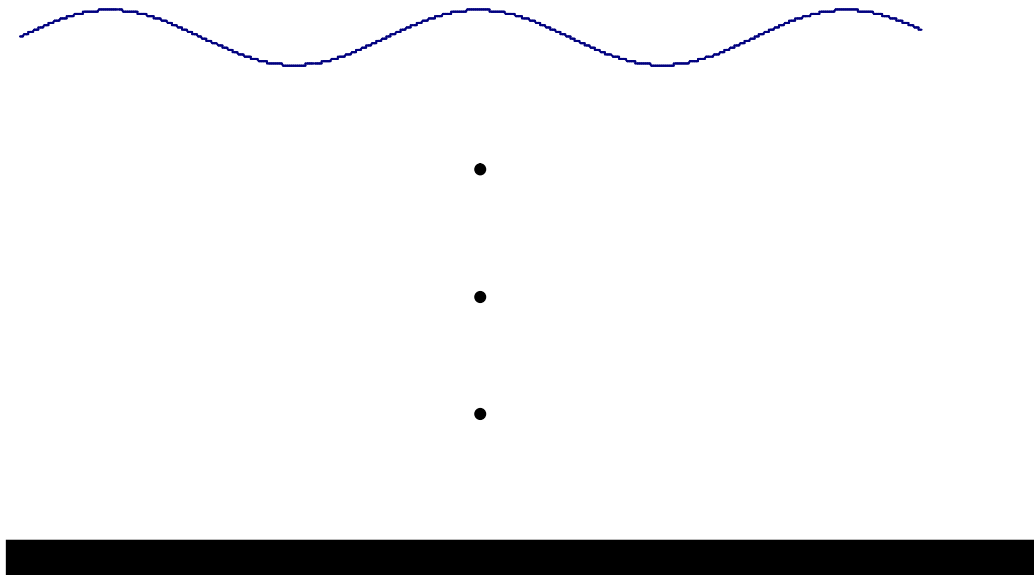
Profiles c) and d) show water columns with constant salinity and variable temperature. Which profile is more stable?



The following charts show real CTD data from a summertime cruise to the Eastern Tropical North Pacific. The two profiles were taken in the same location, 18 hours apart. Does the first profile show a stable water column? What is different about the second profile? What may have caused this change?



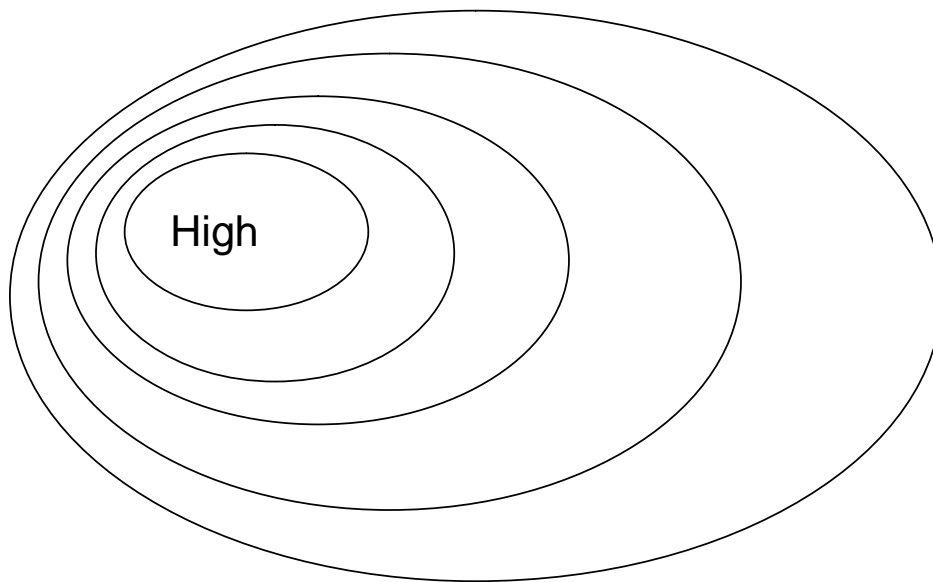
Question 8. (8 points) The diagram below shows a wave travelling over the ocean bottom. Is this a shallow water wave or a deep water wave? Why? Draw the path taken by each of the three black dots as the wave passes overhead.



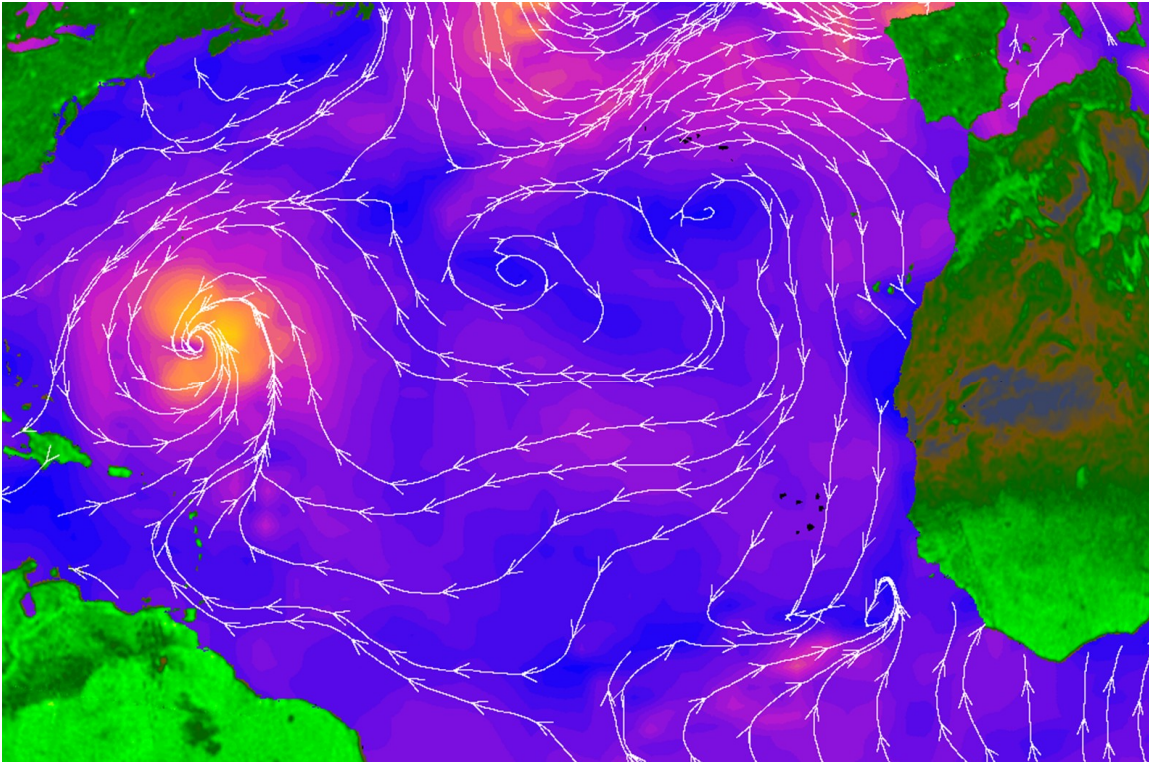
An earthquake in Japan has generated a tsunami wave that is travelling across the Pacific Ocean and heading towards Hawaii. Its wavelength is about 200 kilometers (125 miles). Is it a shallow water wave or a deep water wave? If the distance between Japan and Hawaii is around 3,800 miles, or 6000 kilometers, about how much time does the Tsunami Warning Center have to get Hawaiians to move to safety? Show your work and state any assumptions that you make.

Question 9. (5 points) Define geostrophic balance.

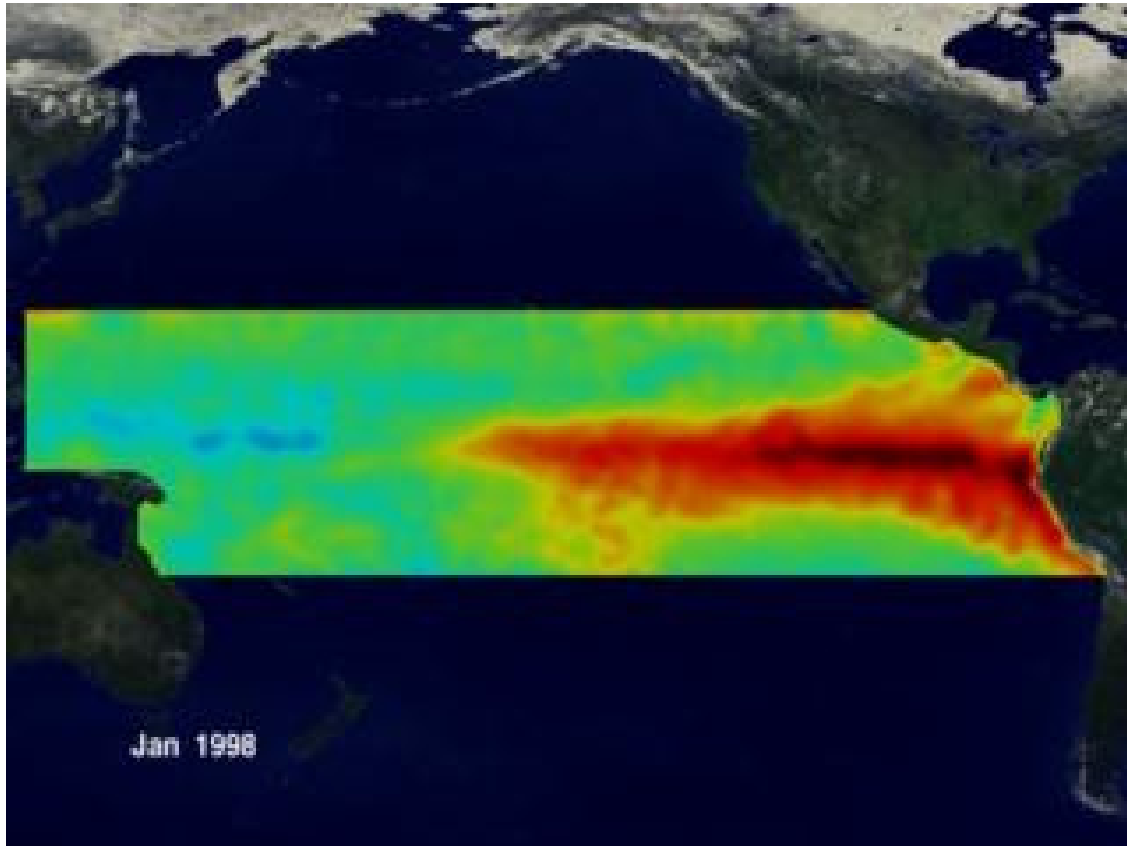
The following cartoon shows contours of the sea surface height in the South Atlantic. Draw on the cartoon the direction of the geostrophic flow and indicate where the geostrophic flow is likely to be the fastest.



Question 10 (4 points). Consider this satellite image of winds over the Atlantic Ocean. Colors indicate wind speed with orange as the fastest wind speeds and blue as the slowest. White streamlines indicate the wind direction. Draw arrows to indicate the direction of Ekman transport off the West Coast of Africa. Describe the effect of this wind field on sea surface temperature and fisheries in this region.



Question 11. (5 points) The image below shows sea surface temperature anomalies (differences from normal values) in the tropical Pacific in January 1998. Name the major weather event that is taking place. Describe what is happening below the surface to cause the anomalous sea surface temperatures. Describe one impact of this event on people living near the eastern edge of the Pacific and one impact of this event on people living near the western edge of the Pacific.



Question 12. (5 points) Consider this aerial photograph of Belmar, New Jersey. Label a groin. Draw an arrow indicating the dominant direction of waves hitting this section of the Jersey Shore. Draw an arrow indicating the direction that sand moves along this section of the Jersey Shore. Do you think that building groins on beaches is a good idea? Say why or why not.

